VOLUME TWELVE NUMBER THREE

JOURNAL OF ENTOMOLOGY AND ZOOLOGY

SEPTEMBER, 1920

PUBLISHED QUARTERLY BY
POMONA COLLEGE DEPARTMENT *of* ZOOLOGY
CLAREMONT, CALIFORNIA, U. S. A.

CONTENTS

Entered Claremont, Cal., Post-Office Oct. 1, 1910, as second-class matter, under Act of Congress of March 3, 1879

Journal of Entomology and Zoology

EDITED BY POMONA COLLEGE, DEPARTMENT OF ZOOLOGY

Subscription $1.00 to domestic, $1.25 to foreign countries.

This journal is especially offered in exchange for zoological and entomological journals, proceedings, transactions, reports of societies, museums, laboratories and expeditions.

The pages of the journal are especially open to western entomologists and zoologists. Notes and papers relating to western and Californian forms and conditions are particularly desired, but short morphological, systematic or economic studies from any locality will be considered for publication.

Manuscripts submitted should be typewritten on one side of paper about 8 by 11 inches. Foot notes, tables, explanations of figures, etc., should be written on separate sheets. Foot notes and figures should be numbered consecutively throughout. The desired position of foot notes and figures should be clearly indicated in the manuscript.

Figures should be drawn so that they may be reproduced as line cuts so far as possible. An unusually large number of half tones must be paid for in part by the author. Other more expensive illustrations will be furnished at cost. Figures for cuts should be made to conform to the size of the page when reduced, that is, 5 by 7½ inches or less. The lettering should be by means of printed numbers and letters pasted on the drawings, in most cases.

Authors of articles longer than a thousand words will receive fifty reprints of their publications free of cost. If more than this are desired, the order should be given with the return of the proof sheets. Extra copies and special covers or special paper will be furnished at cost. Authors of short contributions will receive a few extra copies of the number containing their articles.

Manuscripts should be sent by express or registered mail.

Address all communications to

THE JOURNAL OF ENTOMOLOGY AND ZOOLOGY

William A. Hilton, Editor

Claremont, California, U. S. A.

A List and Some Notes on the Lizards and Snakes Represented in the Pomona College Museum

RAYMOND B. COWLES

The purpose of this article is to give a general idea as to the distribution of snakes and lizards from the desert regions of Southern California, with a few observations on their habits. It is also an enumeration of the snakes and lizards which may be met with in the region about Claremont.

The list has been compiled from specimens in the Pomona College Museum only, and the writer is well aware that not all the specimens from the Claremont and desert regions are represented. No effort is made to give the limits of the range of the specimens nor to give any conclusions as final. In those cases where a list is given of the places from which specimens were taken, it is merely to show that the range is at least of that extent.

Testudo agassizi (Cooper).

One of these desert tortoise was taken at Ludlow, California, towards the last of April, 1920. It was found out in the open at the base of an alluvial fan, and made no effort to escape capture. It is being kept alive with a view to study its habits so far as possible under artificial conditions.

Dipsosaurus dorsalis (Baird and Girard).

Taken from fifteen miles east of Blythe Junction, April 2, 1920, in the sand hills. A second specimen was taken 45 miles west of Blythe, in a sand wash, on April 4, 1920.

The main habitat of this lizard seems to be the sand hills or sandy country, and it takes refuge in the holes of rats when menaced.

During August of 1919 they were seen in pairs and seemed to be breeding. Observations seemed to show that a given pair occupied the same territory and rarely traveled far from it. They were seen most on the hottest days, feeding on the leaves of some of the low desert shrubs. Upon being frightned they would drop from the branches and run rapidly, with the entire body raised from the ground, to the nearest burrow, where they would remain for half an hour or more before reappearing. On cloudy days, even though the temperature remained above 100° F. they were seldom seen and appeared to be very sluggish, sometimes allowing one to approach to within a few feet of them before running.

Their food seemed to be almost exclusively plants, and they preferred the leaves of an alfalfa plant which happened to be growing near their chosen range. During an entire summer, June 25 until September 25, they were seen eating insects only once. The specimen eating the insect escaped and it is not know what insect it might be, though from a distance it appeared to be one of the Acrididae.

Uma notata (Baird).

Only one specimen of this beautiful lizard is found in the museum, and it was taken in the sand hills 15 miles east of Blythe Junction, April 2, 1920. The lizard is very shy, running rapidly to the shelter of a burrow in the sand, at the least threat of danger. (This seems to be between *U. notata and U. scoparia.*)

Calisaurus ventralis ventralis (Hallowell).

This lizard appears to be one of the most numerous and widely distributed of the Colorado and Mojave deserts, having been found in almost every type of country with the exception of the rocky hills and mountains, from Victorville to Needles and south to the Mexican Border in Imperial Valley. In the Providence Mountains they were found at an altitude of over a thousand feet.

In the Imperial Valley they were found to burrow, or push down into the sand at the approach of night. Here they remained until sunrise of the next day. At the approach of danger they jump from the sand with such suddenness as to give the impression of a small explosion.

The distribution as given above is not intended as a limit to their range but merely a note on their presence in those places.

Crotaphytus collaris baileyi (Stejneger).

This lizard is represented by three specimens in the college collection. One taken from near the Bonanza King Mine, Providence Mountains, March 31, 1920; another from the N. E. spur of the Turtle Mountains, and a second and smaller one from the same place, April 1, 1920.

These lizards were found on the rocky hill-sides and were very active and rather shy. Their strong jaws and great speed fit them for the predaceous life which they lead. In the largest specimen was found an eight inch *Cnemidophorus tigris tigris*, partially digested.

Crotaphytus wizlizenii (Baird and Girard).

Two specimens were taken at the grass fields between Blythe and Mecca, on April 2, 1920.

These specimens were found skulking under the branches of the creosote bushes. They are very rapid runners, and are predaceous. Their coloring blends admirably into the mottled shade where they lie in wait for their prey. A ten-inch *Cnemidophorus tigris tigris* was taken from an eleven inch specimen. Their biting ability was well proved upon the collector who picked up one of the specimens which had been only wounded. One bite tore through the skin of the first finger, causing a decided flow of blood.

Sauromalus ater (Dumeril).

One specimen taken in the lava rocks east of Ludlow, March 30, 1920. Two specimens taken among the rocks in the N. E. spur of the Turtle Mountains.

These lizards, which are not fast runners, are usually found near some crevice in the rocks in which they take refuge upon the approach of danger.

The two specimens taken in the Turtle Mountains, April 1, 1920, were found as a pair, and when first seen appeared to be in copula. This gives some suggestion as to the time of breeding.

Uta Stansburiana elegans (Yarrow).

Several specimens were taken during the first week in April, and they seem to be farily common throughout a large part of the Mojave and Colorado deserts, in California at least.

Sceloporus magister (Hallowell).

One specimen taken 35 miles east of Mecca, California, April 2, 1920. Other specimens taken during July and August, east of Holtville, California. These lizards seem to prefer the brushy country or the neighborhood of trees, into which they climb when frightened. The specimen taken east of Mecca was found on the ground beneath a cactus.

Phyrnosoma platyrhinos (Girard).

Representatives from five miles west of Amboy and Needles, California. Without an exception they were found on the dry gravelly washes or in the sand not far from washes.

Xantusia vigilis (Baird).

Three specimens from east of Victorville, and one from the Providence Mountains, near Bonanza King Mine, March 30, 1920. These specimens were all found beneath the bark of prostrate yuccas.

Cnemidophorus tigris tigris (Baïrd and Girard).

These lizards appear to be one of the most common found on the Colorado and Mojave deserts in California. Their range is extremely varied, specimens being taken from, and between, Victorville, Needles, Blythe, the Mexican border in Imperial Valley, and Palm Canyon. These localities are not given as the limits of the range but places within the range from which we have specimens. Specimens were taken in the Salton Sink 265 feet below sea level, and from the Providence Mountains at an approximate altitude of 2,800 feet above sea level.

Sonora occipitalis (Hallowell).

One specimen taken at the grass-fields, between Blythe and Mecca, California. When taken it was traveling out in the open and in the heat of the noon sun, April 3, 1920. It was found on a gravel wash and when approached it struck in all directions, though apparently it did not open its mouth upon striking the hand. It appeared to be blinded by the sun and unable to tell from which direction it was menaced.

Bascanion flagellum frenatum.

Two specimens, both taken near Mecca, Imperial Valley, April 4, 1920. Both these specimens were somewhat lighter than specimens taken from the region around Claremont, California.

One of these snakes was obtained under rather unusual circumstances, which incidentally involved the collecting of a *Cnemidophorus tigris tigris.* The lizard was shot but not killed by the collector, and while watching for an opportunity to kill the lizard without the use of a second shot, the snake was seen gliding in the same direction as the lizard, and suddenly attacked and seized it, when both were added to the collection.

Crotalus mitchelli (Cope).

This specimen was collected by Dr. Hilton and Dr. Munz of Pomona College, at Forest Home, San Bernardino Mountains, June 7, 1919.

Crotalus cerastes (Hallowell).

One specimen taken at Needles, California, April 1, 1920. These snakes seem to be almost entirely restricted to the sandy areas of the desert, rarely wandering from them, and then only for a short distance, its mode of locomotion admirably fits it for the type of country which it inhabits. The ordinary snake finds difficulty in rapid motion over the loose and shifting sand, since part of the tractive power comes from a bracing of each loop of the body against that part of the ground which is posterior to the loop, and through the movement of the central portion of the body against the surface of the ground. It can readily be seen that a shifting and loose surface would seriously hinder the progress of the ordinary snake. The "Side-winder," *Crotalus cerastes,* instead of progressing as do ordinary snakes, longitudinally, progresses laterally, leaving separate tracks, each paralleling the other, and angling in the direction in which the snake is moving. Each track is approximately the length of the snake making it, and is wavy, that is, a series of "S" shaped loops. The tracks give no sign of any part of the body moving from one mark to the other, which gives the impression that the snake jumps the 3 to 6 inch interval between the tracks. Such is not the case, however. When the snake is moving, the body is kept partially looped and the advance seems to be through the advancing of the head and tail, while the rest of the body is rested on the intervening loop, supporting the rest of the body, the weight then seems to be shifted to the head and tail and the rest of the body advanced, the whole progression being a series of graceful and continuous movements. This *seems* to be the mode of progression.

Crotalus atrox (Baird and Girard).

Taken at Mecca, California, April 4, 1920. Found in the arrow weed where it seemed to be fairly common.

In addition to the above list of specimens from the desert region there remain that from the vicinity of Claremont, California, which is as follows: *Uta stansburiana hesperis,* Richardson; *Sceloporus occidentalis bi-seriatus,* Hallowell; *Phrynosoma blainvillii blainvillii,* Gray; *Gerrhonotus scincicauda webbii,* Baird; *Anniella pulchra pulchra,* Gray; *Anniella pluchra nigra,* Fisher(doubtful location. Specimen not labeled. Another from Laguna Beach August 1, 1920); *Cnemidophorus tigris stejnegeri,* Van Denburgh; *Plestiodon skiltonianum,* Baird and Girard; *Lichanura roseofusca,* Cope (two taken from vicinity of Claremont and one from east of Victorville by W. M. Pierce); *Thamnophis ordinoides hamondii,* Kennicott; *Diadophis amabilis,* Baird and Girard; *Lampropeltis pyromelana multicincta,* Yarrow; *Lampropeltis boylii,* Baird and Girard; *Rhinocheilus lecontei,* Baird and Girard; *Hypsiglena ochrorhynchus,* Cope; *Salvadora hexalepis,* Cope (taken in Imperial Valley 10 miles east of Holtville); *Coluber constrictor vetustus,* Baird and Girard; *Coluber flagellum frenatus,* Stejneger; *Coluber lateralis,* Hallowell; *Pituophis catenifer catenifer,* Blainville; *Crotalus oreganus,* Holbrook.

The Central Nervous System of an Unknown Species of Marine Leach

WILLIAM A. HILTON

The little animals from which this study was made were obtained during the summer of 1920 at Laguna Beach. Two times when a number of *Mysis* shrimps were brought in with towings these worms were found attached by the posterior sucker to the side of the crustacean. At first it was not clear to which group of animals these small creatures belonged. It was not until a number of the specimens had been cut in series that their nature was learned. Externally they seemed unsegmented, although the body had many circular rings when contracted by reagents, but these rings were evidently not marks of segmentation. Internally at first there also seemed to be little trace of metamerism, but when the nervous system was examined a clearly defined chain of ganglia was evident.

The mouth is at the base of the large anterior sucker, and it is back of this that the ganglia may be seen. The chief ganglion is the suboesophageal composed of about four parts fused and closely applied to the next ganglion below. The brain or supraoesophageal ganglion is unimportant; in fact, it is the smallest of all. There are sixteen sinmple ganglia forming the ventral chain back of the subœsophageal and the seventeenth ganglion or last of the chain. The last center, or the seventeenth, is made up of at least three simple ganglia fused and is the second most important center. It supplies the structures of the large posterior sucker.

Some of the points of special interest in the nervous system of this creature are:

1. Lack of true metamerism except in the nervous system.

2. The large number of simple clearly defined nerve centers. About four centers are represented in the suboesophageal, sixteen separate ganglia and at least three separate centers for the last ganglion. In all then there are at last twenty-three centers in the nervous system.

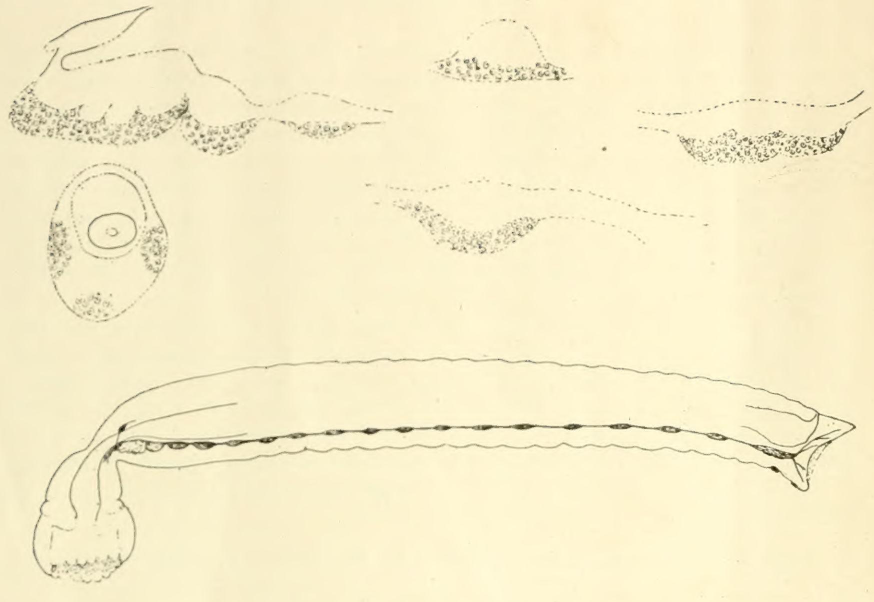
3. The small size of the supraoesophageal ganglion or brain.

4. The large size of the subœsophageal ganglion and the last ganglion.

5. No special sense organs were located.

The specimens were from 4-8 mm. in length and, although small, were sexually mature. The identity of the species will be considered at another time.

(Contribution from the Zoological Laboratory of Pomona College.)



EXPLANATION OF FIGURES

Below, the general position of the ganglia is shown. On the left above is an enlarged longitudinal section of the upper ganglia and just below it a cross-section through the brain and subœsophageal with the œsophagus in the space between. The two upper central figures are longitudinal and cross-sections of about the tenth ganglion. The last figure to the left is a longitudinal section of the last ganglion. The dorsal side is up in all the figures. The sections are all enlarged 170 times, the figure of the whole animal is enlarged 20 times.

Central Nervous System of a Centipede

ARTHUR S. CAMPBELL

The central nervous system of *S. Polymorpha* Woods, is especially studied in the present paper.

Hymonds (1898) considers the development giving especial note to the homologies of this system. Newport (1843) gives some notes in regard to the brain. Saint-Remy (1890) gives considerable detail especially in regard to the finer structure of the brain of *S. Morsitans L.* Case (1920) has shown something of the behavior of *S. Polymopha* and indirectly the arrangement of never tracts.

Ordinary dissections and the occaasional use of a binocular microscope proved the most useful.

Successful stains were Heidenh~~ei~~ain m's and Delafield's Haem~~e~~atoxylins. $HgCl_2$ or $AgNO_3$ seemed the best fixers. Tracheae were studied without reagents immediately after exposure.

In *S. Polymorpha* the supraoesophagal ganglion or brain comprises three paired, fused divisions or lobes. Large branches extend from the antennal lobes into the antennae. The ocular lobe fuses with this and is distinctly larger and less markedly bilobate. This lobe sends out nerves to the oceili. The labro-fontal division is underneath the ocular lobe and entirely fused with it. It innervates the labrum.

The supraoesophageal ganglion in *S. Polymorpha* is large. It is anteriorally connected with the brain by two circumoral connectives. Ten principal, paried nerves are connected with this ganglion. The anterior pair extend into the mandibles. The second pair supplies the first maxillae, the third runs to the second maxillae. The fourth pair innervates the maxillipeds. The fifth pair supplies the prehensorial feet.

The remaining somites are supplied by simple, similar ganglia, equally spaced but well separated by connectives. The third and fourth ganglia area almost fused, due to the foreshortened segments in which they are located. There is no histological difference between them and other abdominal ganglia. One ganglion only is present in each somite. Altogether in *S. Polymorpha* there are twenty-four ganglia.

Each abdominal ganglion gives off eight nerves. There is no ventral nerve. The first pair of branches supplies the tergular muscles, the second the walking legs, the third the sternal muscles and the fourth supplies the spiracles and tracheae.

The two caudal ganglia present special interest. Four principal branches run from the first of these. The first supplies the tergal muscles, the second the sternal muscles while the fourth supplies the anal legs. Additionally, two preanal connectives join with a small ganglia about half the normal size of the others. Four nerves extend from this last small ganglion into the sphincter and other anal muscles.

In general the superficial tracheal distribution is rather definite and much resembles that of the insects. The brain is rather poorly supplied by but two main tracheae on either side which break up into a number of tracheoles which run into the antennae and optic lobes. In contrast to this, the suboesophageal ganglion is supplied dorsally by three tracheaae on each side.

The abdominal ganglia are each supplied by two ventral tracheae. The dorsal tracheae send vessels throughout the length of the branches on the dorsum of the ganglion. Each ganglion is well supplied by numerous small tracheoles.

The two candal ganglia present some differences in the distribution of tracheal elements. The dorsal surfaces of the twenty-third and twenty-fourth ganglia is supplied by six tracheae. Ventrally there is one principal branch suppling both by numerous tracheoles.

Histologically the brain and other ganglia resemble much those of the more generalized insects. I have found little difference in my specimens and those figured by Saint-Remy (1890) of *S. Morsitans.* The cellular masses of all my preparations seem much less than those figured by Saint-Remy. The fibrous area of the brain contains some indication of lobular masses. There are at least two sizes of cells noticeable.

In the abdominal ganglia the fibrous mass occupies rather more than half the bulk. The cellular area, composed of several sizes of cells, is closely crowded.

The caudal ganglia contain less bulk of the fibrous mass and a large area of cells. The cells here seem to be all of approximately the same size and type.

In all preparations, the nuclei appear large, the nucleoli show prominently. Tigroid substances was noticed in a few of the larger, better stained cells, especially in the brain. Fibrils were seen to enter into certain cells, and touch the nuclei.

CONCLUSIONS

1. The central nervous system of *S. Polymorpha* is composed of twenty-four generalized ganglia. The brain is less complex than that of the insects.
2. Of the three primitive elements of the brain two only are externally apparent.
3. Tracheae supplying the central nervous system are definitely arranged.
4. The functional cells of the central nervous system are of several sizes, the fibrous mass makes up the greater bulk of the ganglion. The cellular area is external and relatively less abundant.
5. Nuclei are large, nucleoli are well marked. Fibrils appear to come into contact with nuclei.

BIBLIOGRAPHY

Case, S.: General Reactions of a Centipede. 1920
Journal of Entomology and Zoology.

Heymonds: 1898
Zur Entwicklungsgeschichte der Chilopoden.
Sitzungslier K. press. Akad. Wissenschaft.

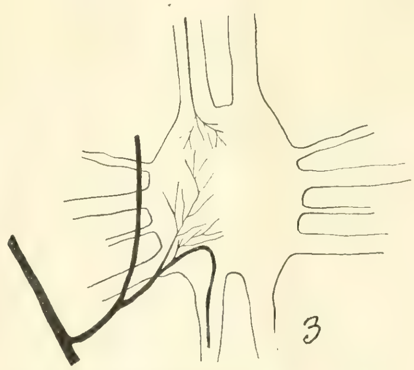
————————: 1901
Die Entwicklungsgeschichte der Scolopender.
Zoologia, Heft. 33.

Newport, George: 1843
Structure, Relations and Development of the Nervous and Circulatory.
Systems - - - in Myriopoda and Macrourous Arachnida.
Philos. Transactions of the Royal Society.

Saint-Remy, G: 1890
Contributions à l'étude du cerveau chez les Arthropodes Trachéates.
Archiv. Zool. Expér. Tome V. suppl. 1887-90.

(Contribution from the Zoological Laboratory of Pomona College.)

2



3

Fig. 1. Brain and subœsophageal ganglion; tracheæ black. X6.

Fig. 2. Twenty-third and fourth ganglion. X5.

Fig. 3. Abdominal ganglion. X5.

Microscopic Studies of the Water of the Claremont-Laguna Region

GENEVEIVE CORWIN

The climatic conditions in Southern California where these studies were made, are unusual in that the rainy season occurs during the winter and early spring and there is practically no rainfall for the rest of the year. About 10 to 15 inches is the average yearly amount. With this small amount of precipitation, most of the streams dry up completely and the permanent pools diminish in size. This fact has a profound effect upon the life contained in the water. Just how this effect works out has not been determined. Some forms are able to dry up and still retain life, while others are killed by lack of moisture. Almost all the studies recorded in this paper were made on permanent pools and streams.

Studies of the microscopic life of the Claremont-Laguna region were made in the early spring and summer, those of the Claremont region in February, March and April; and of the Laguna region during the last half of June and the month of July of the previous year.

Considering the two places as a whole, in general there were more green algae than blue-green; more algae than Protozoa, the amoeboid Protozoa being fewest in number; the flagellate a little more numerous and the ciliate most frequent, both in species and individuals. The rotifers were rather rare, but were quite varied in form, from the simply constructed, active *Colurus* to the beautifully ciliated fixed *Floscularia*. The *Gastrotricha* were very rare.

The chief difference between the Caremont and the Laguna regions is the abundance of aquatic life. This might be caused by the fact that most of the pools studied around the Laguna were close to the shore and the water may have been brackish. As a rule they were more stagnant than the Claremont water, with the exception of the Laguna Lakes. Perhaps the seasonal change may have had something to do with this difference. The Claremont studies were made over a period of time twice as long as the other and much earlier in the season. However this may be, in almost every group there were more species in the Claremont region than the Laguna and in all other cases there were at least as many, with the one exception of the one desmid found in Claremont and not in Laguna. To summarize the comparison: There were twice as many species of algæ in the Claremont region as the Laguna; the same number of blue-green for both localitis but four times as many green in Clarement. The diatoms were quite numerous and varied in form in both places but there were only half as many species in Laguna. As mentioned before, one desmid was found in Clarement and none in Laguna.

The Protozoa were quite abundant in both regions, there being three times as many in Claremont as in Laguna. In Claremont the amoeboid were twice as numerous as at Laguna. There was a larger proportion of beautiful complicated forms in the Claremont region. There were three species of *Stentor* in Claremont and only two in Laguna. The restless little *Euplotes*, the graceful *Spirostomium*, the beautiful *Stylonychia* are illustrations of the variety of ciliates in Claremont.

There were one-half more rotifers in Claremont than Laguna. However, Laguna had in comparative abundance the very interesting form, *Rotifer neptunis.* This form is quite long and slender when extended, with two rosettes of cilia and a quite unmistakable Neptune's trident at the end of the tail. It is very collapsable, telescoping down to one-third of its extended length. This was peculiar to the smaller Laguna Lake.

Claremont showed several specimens of *Brachionus.* I am not certain of the species but the name must stand for want of a better one. It was a large form with two magnificent wheels of cilia and two short slender arms, each bearing a tuft of cila. When the animal drew in the wheels of cilia at least one of these arms remained exposed. It was rather sedentary, fastening its two small toes to a piece of algae and bending its flexible, stout body in different directions to search for food.

Only one *Gastrotricha* was found in the Claremont region while this same genus *(Chaetonotus)* was found in two different places and more than one individual was seen.

Microscopic Crustacea were rather rare, only one *(Cyclops)* being found in the Sulphur Spring at Laguna. Three other kinds were found in the Claremont region, two in the South Hills, the other at Puddingstone Canyon and in the Puente Hills.

One water mite was found in Claremont in a temporary pool and in no other place.

The comparison between the temporary and permanent pools is not adequate on account of the scarcity of data. In a general way, there is a smaller variety and number of forms in the temporary than in the permanent pools. Streams and permanent pools are similar in the amount of life they contain.

Preliminary List of Microscopic Life in Fresh Water Pools Around Laguna Beach

I. Algae

A. Blue-green

1. Oscillatoria: found in
   - Algae Pool
   - Smallest Laguna Lake
   - Largest Laguna Lake
2. Spirulina
   - Smallest Laguna Lake
   - Largest Laguna Lake
   - Algae Pool
   - Laguna Canyon Pool
3. Nostoc
   - Smallest Laguna Pool
   - Algae Pool
   - Laguna Canyon Pool
4. Nodularia
   - Laguna Slough
5. Phormidium
   - Smallest Laguna Lake

B. Green

1. Cladophora
   - Salt Spring
2. Synedra
   - Laguna Canyon
   - Smallest Laguna Lake
3. Ankistrodesmus
   - Algae Pool
   - Laguna Slough
4. Spirogyra
   - Laguna Canyon Pool
   - Laguna Slough
   - Smaller Laguna Lake
5. Scenedesmus
   - Largest Laguna Lake
6. Navicula
   - Laguna Canyon
   - Algae Pool
   - Salt Spring
   - Sulphur Spring
   - Smallest L. Lake
7. Amphora
   - Algae Pool
8. Cymbella
   - Sulphur Spring
   - Smallest Laguna Lake
   - Largest Laguna Lake
9. Pinnularia
   - Smallest Laguna Lake
   - Salt Spring
10. Gomphonema
    - Smallest Laguna Lake
11. Closterium
    - Smallest Laguna Lake
12. Pleurosigma
    - Smallest Laguna Lake
13. Epithemia
    - Smallest Laguna Lake

III. Protozoa

A. Amoeboid

1. Amoeba
   - Algae Pool
2. Nuclearia
   - Salt Spring

B. Flagellate

1. Euglena spirogyra
   - Smallest Laguna Lake
2. Euglena sp.
   - Laguna Canyon
   - Laguna Slough
3. Phacus longicaudis
   - Smallest Laguna Lake
   - Laguna Canyon

C. Ciliate

1. Gonium
   - Smallest Laguna Lake
1. Flexiphyllum
   - Smallest Laguna Lake
3. Condylostoma
   - Smallest Laguna Lake
   - Largest Laguna Lake

Laguna Canyon

4. Paramoecium
   Laguna Slough
   Algae Pool
   Sulphur Spring
   Salt Spring
5. Lacrymaria
   Laguna Canyon
6. Stentor (fixed)
   Laguna Canyon Stentor (moving) Smaller L. Lake
7. Vorticella
   Smallest Laguna Lake
   Laguna Slough
   Algae Pool
   Laguna Canyon
8. Volvox
   Largest Laguna Lake

IV. Flat Worms
   1. Jensenia
      Laguna Canyon

V. Round Worms
   Smallest Laguna Lake
   Laguna Canyon
   Algae Pool

VI. Rotatoria
   A. Rotifer neptunis
      Smallest Laguna Lake
   B. Rotifer citrinus
      Sulphur Spring
      Salt Spring
      Laguna Canyon
   C. Diplois
      Smallest Laguna Lake
   D. Colurus grallator
      Smallest Laguna Lake
      Salt Spring
      Laguna Canyon
      Algae Pool
   E. Notius quadricornus
      Smallest Laguna Lake
   F. Philodina roseola
      Laguna Canyon

VII. Gastrotricha
   A. Chaetonotus
      Laguna Canyon
      Smallest Laguna Lake

VIII. Copepoda
   A. Cyclops
      Sulphur Spring

Preliminary List of Microscopic Life in Fresh Water Around Claremont

The numbers after the genera refer to the stations where the collections were made.

I. Algae

A. Blue-green

2. Oscillatoria 3, 6, 7, 9.
3. Nostoc 1, 9.
4. Merismopedia 2, 3, 4.
5. Spirulina 2.
6. Mastigonema 3.

B. Green

1. Vaucheria 11.
2. Cladophora 4, 8, 11, 13, 14, 15.
3. Clamydomonas 2, 3, 7, 8, 13, 14, 15.
4. Gonium 13, 14, 15.
5. Spirogyra 1, 3, 5, 7, 8, 9, 14.
6. Ulothrix 13.
7. Mougeotia 13.
8. Mydrodictyon 2.
9. Pediastrum 2, 12.
10. Scenedesmus 2.
11. Chlorosphaera 3.
12. Chaetophora 8, 9, 14.
13. Zygnema 7, 8.
14. Chlorogonium 7.
15. Myxonema 7.

C. Diatoms

1. Navicula 1, 2, 3, 4, 7, 8, 9, 11, 12, 13, 14, 15.
2. Epithemia 8, 9, 12, 14, 15.
3. Synedra 1, 2, 3, 4, 5, 7, 8, 9, 13, 14, 15.
4. Cocconeis 1, 3, 5, 8, 9, 13, 14, 15.
5. Siurella 7, 8, 12, 13, 14, 15.
6. Gomphonema 1, 2, 3, 4, 5, 7, 8, 13, 15.
7. Amphora 2, 7, 8, 13, 15.
8. Nitzschia 1, 4, 7.
9. Rhoicosphenia 3, 4, 7.
10. Tabellaria 7.
11. Cymbella 2, 13, 15.
12. Selenastrum 2.
13. Cyclotella 2, 4, 13.
14. Pinnularia 2.
15. Encyonema 3, 8, 13, 14.
16. Denticula 3, 5, 8, 11, 14.
17. Eunotia 4, 13, 14.
18. Plagiogramma 4.
20. Triceratium 4.

D. Desmids

1. Cosmarium 3.
2. Closterium 2, 5, 8, 9, 13, 14. 15.

II. Protozoa

A. Amoeboid

1. Actinosphaerium 3.
2. Amoeba limax 1, 13, 14.
3. Amoeba 3.
4. Acanthocystis 13.
5. Noclearia 2, 3.

B. Flagellate

1. Euglena 5, 6, 7, 13, 14, 15.
2. Peranema 6, 7.
3. Notosolemus 6.
4. Eutreptia 6.
5. Atractonema 7.
6. Phacus 7, 15.
7. Astasia 3.
8. Cephalothamnium 1, 13, 14, 15.
9. Urceolus 14.
10. Heteronema 14.
11. Trentonia 15.

C. Ciliate

1. Vorticella 1, 2, 5, 6, 8, 13, 14.
2. Stentor 13, 14, 15.
3. Stentor polymorphus 14, 15.
4. Linotus 14.
5. Colpodium 12.
6. Leucophrys 7, 14.
7. Euplotes 1, 3, 6, 8, 13, 14.

8. Cinetochilum 3, 4, 14.
9. Cothurnia 14.
10. Paramoecium 1, 2, 3, 6, 8, 15.
11. Pleuronema 2, 7, 8.
12. Stylonychia (long) 2, 3, 7, 8, 12.
13. Stylonychia (oval 8, 15.
14. Oxytricha 5, 8, 10.
15. Chilodon 1, 3.
16. Chaenia 1, 2, 3, 6, 8, 11.
17. Atractonema 1.
18. Ophryglena 1.
19. Frontonia 1.
20. Glaucoma 2.
21. Condylostoma 3.
22. Coleps 3, 8, 15.
23. Colpoda 8, 12.
24. Metopus 8.
25. Halteria 7.
26. Spirostomium 6.
27. Blepharisma 15.
28. Opercularia 15.

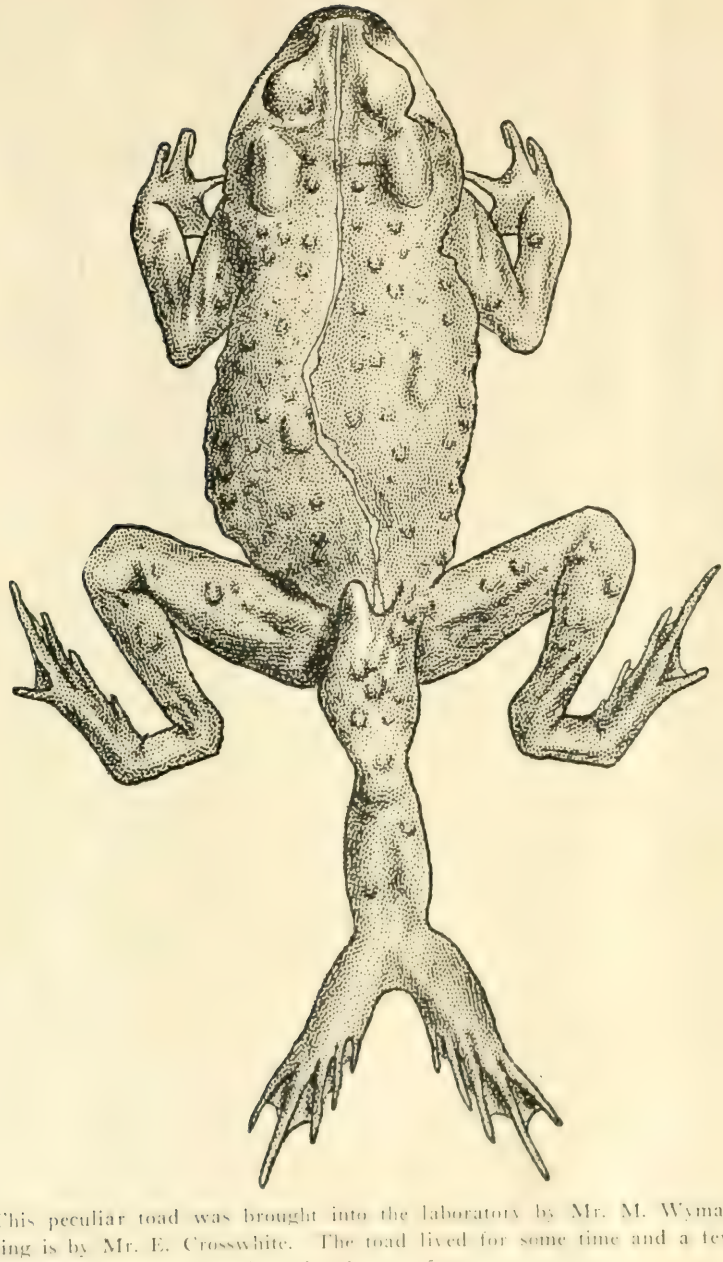
III. Rotifera
1. Pleurotrocha 8.
2. Philodina 6, 8.
3. Gastropus 1.
4. Diplax 3.
5. Diplois 1, 13, 14, 15.
6. Branchionus 5, 13, 14, 15.
7. Rattulus 14.
8. Floscularia 14.
9. Diaschiza 13, 15.
10. Melicerta 15.

IV. Gastrotricha
1. Chaetonotus

V. Crustacea
A. Ostracoda
1. Cypris 7, 9.
2. Herpetocypris 11.

B. Cladocera
1. Alonella 11.

(Contribution from the Zoological Laboratory of Pomona College.)



This peculiar toad was brought into the laboratory by Mr. M. Wyman. The drawing is by Mr. E. Crosswhite. The toad lived for some time and a few things were learned about its extra leg with the two feet.

1. It was capable of feeble movements of the leg and feet.
2. There was no true joint at the junction of the fifth leg with the body.
3. The extra leg was dragged along with no attempt made to use it in any way.
4. The extra leg could be used as a brace when the toad tried to climb from a jar.

(Contribution from the Zoological Laboratory of Pomona College.)

General Reactions of a Centipede

SUSIE CASE

This paper deals with the locomotion and general reactions resulting from experimentation upon the nervous system of centipedes. The nervous systems of these forms are very good for such experimentation, as the ganglia are distinct and widely separated.

There seem to be but three or four papers on the subject—two of these being on the physiology of the brain and *not* behavior, and one, "On the Movements of Millipedes and Centipedes" by E. Ray Lankester. I should like to mention several points which were observed along this last line. The locomotion of the centipede can be better emphasized by comparing it with that of the millipede. In the millipede one of the most apparent characteristics is the movement of the legs in waves, the pairs on opposite sides moving together, identically. The legs form groups of two pairs to a segment and these start the motion from the tail end forward. From five to eight distinct waves can be counted when all the legs are in motion. Millipedes move straight forward. On the other hand, the centipede as stated by Lankester, "contributes the serpentine stroke to the process of locomotion." It does not have the distinct waves mentioned in locomotion of the millipede. The legs on the opposite side do not move identically but are antagonistic in phase; and move in perfect harmony unless there be some injury to the nervous system, which controls locomotion. I agree with Lankester that it is most probable that the condition presented by the centipede in locomotion is a higher development than that shown by the millipede. The wave movement suggests a type found in lower invertebrates.

Th reverse locomotion of the centipede is very interesting. Most of them *persist* in going forward and yet in testing to find some definite result, I have discovered that occasionally they will, with persuasion, go backward. Most often, however, they turn the entire body instead of reversing the movements of the legs. On the other hand, all millipedes with persuasion will reverse for a short distance. When one goes backwards, it reverses the motion of the waves also, causing them to go from head to tail instead of from tail to head.

I have mentioned the two main observations of general behavior as to locomotion and shall now go on to the definite experiments which were made on the centipede to test specific reactions.

First as to the method: The specimen to be operated upon was pinned out on cork—the pins not being put through the centipede but across in a sufficient number of places to hold it firmly. The cut was made from the dorsal side into the nervous system. We tried not to make the external cut any larger than was absolutely necessary. When in doubt as to the position of the injury, we examined the animal after death.

The experiments and results are as follows:

Experiment I... Twelfth connective cut on right side. Results:

1. Some lack of movement in legs near cut and on same side, probably due to injury of muscles.

2. Tests to see whether stimuli carried from tail end to head end on injured side. Anal leg pinched. We have the suggestion in this that the impulse travels up and crosses over to the opposite side at the injured point, causing the head to turn to the right. On the uninjured side the impulse is able to travel up without crossing. The reaction was quicker than on the injured side.

3. Acetic acid on antennae of injured side. Reaction on opposite side at anal end first. Acetic acid on antennae of uninjured side. Reaction on same side at anal end.

4. When stmulated below cut, both sides respond equally well. All of these tests show that movement is deferred on the injured side.

Experiment II. Similar results obtained by cutting connective in fourteenth segment on right side.

Experiment III. Cut two connectives of twelfth segment. Results:

1. Specimen was turned on its back. It could turn over above injury without aid, was helpless back of injury.
2. Moved legs vigorously above injury; dragged others.
3. Antennae sensitive to touch, causing response back to injury.

Experiment IV. Results similar to experiment three obtained by cutting two connectives between last two ganglia.

Experiment V. Connectives cut between brain and sub-ganglion. Results:

1. Stimulated antennae. No response.
2. Stimulate anal leg. Impulse traveled along slowly, causing all legs to move. This seems to be a muscular reaction rather than one controlled by the nervous system.
3. One response in which I was very much interested was that the centipede, as a result of this particular experiment, reversed movement with apparent ease.

Experiment VI. Two alternating connectives cut. Results:

1. Specimen very active. Tests showed good crossing of sensation paths.

Experiment VII. Four cuts alternating excepting for second cut. Between cuts one and two connectives not severed on either side. Results:

1. Test to see whether stimuli carried to brain. Very slight stimulus at anal leg, caused only reaction in legs back of injury. Strong stimulus, caused stimulus to go to brain but it was very slow, due to the number of injuries. The stimulus had to cross at several points.
2. There is apparent separation of brain from anal end by injuries. The legs in front of injuries in constant motion, while those in back are quiet.
3. Stimulated head region. Result is a very active reaction, which takes place almost immediately, back to the injured part. There was much delay here. Gradually the response extended farther down.

Experiment VIII. Connective cut on left side in fifth segment from head. Connective cut on right side in fourth segment from tail. In this experiment I wanted to test for time of response when cuts are on opposite sides and quite a distance apart. Results:

1. Anal legs stimulated. On the right side it took longer for the response at the head end. On the left side it was carried immediately to brain. This was probably due to the position of the segment where crossing over took place.

2. Legs stimulated at center of body. Anal end drew up on the side stimulated. This reaction took longer on the right side, because the stimulus had to cross at the injury.

3. From the injury of the nervous system of the muscles, the specimen moved with a swinging motion. It could reverse its movements.

Experiment IX. About one-third of the brain was removed, the right connective was severed between the brain and the next ganglia, all connections with the eye were severed on the same side. Results:

1. No co-ordination of leg movement. Legs interfered with one another.

2. At first, no sense of correct position. As willing to stay on back as normal position.

3. Most noticeable result was that it reversed movement with apparently as much ease as it went forward. It traveled the length of the dish. This centipede lived twenty-four hours.

Experiment X. Removed sub and supra ganglia. Results:

1. Had better co-ordination of leg movement than one with one-third of brain removed *(Experiment IX),* however, it needed stimulation for movement. A slight jar of the dish was stimulus enough for the reaction. After this experiment the centipede lived sixty hours, thus showing the injury to be less of a shock than in experiment nine.

Experiment XI. The centipede was cut into nearly equal parts. This last experiment is of a different type but results are along the same line as others. Results:

1. In tail half there seems to be co-ordinated reaction of legs, suggesting that the symmetry has not been interfered with. It turns toward side stimulated. Tail end remained alive a little over two hours.

2. The head end was again cut into two parts. The central section was active and remained alive for two hours. The head end was very active. It had initiative to move without being stimulated, which power the other two parts did not have. The head end remained alive three hours.

GENERAL CONCLUSIONS

1. The head ganglia seem to be necessary to initiate movements.

2. The body ganglia are rather independent centers for local control, and complete co-ordination is possible without the head.

3. The stimuli travel up and down the nervous system, both on the side stimulated and on the opposite side.

4. In case a connective is served on one side, the stimulus is capable of crossing over to the other side but the reaction is somewhat delayed.

5. When alternate connectives are severed for some distance, the stmulus, although delayed, passes from one end to the other. The delay is increased according to the number of connectives severed.

6. Centipedes as compared with millipedes do not as a rule reverse the movements of the legs, but unilateral injuries to the brain seem to permit the reverse movements upon stimulation.

(Contribution from the Zoological Laboratory of Pomona College.)

Notes on the Central Nervous System of a Free-Living Marine Nematode

WILLIAM A. HILTON

The species studied was the one which is most abundant at Laguna Beach among Algæ and in sand at low tide. It corresponds closely to *Enoplus brevis* Duj.

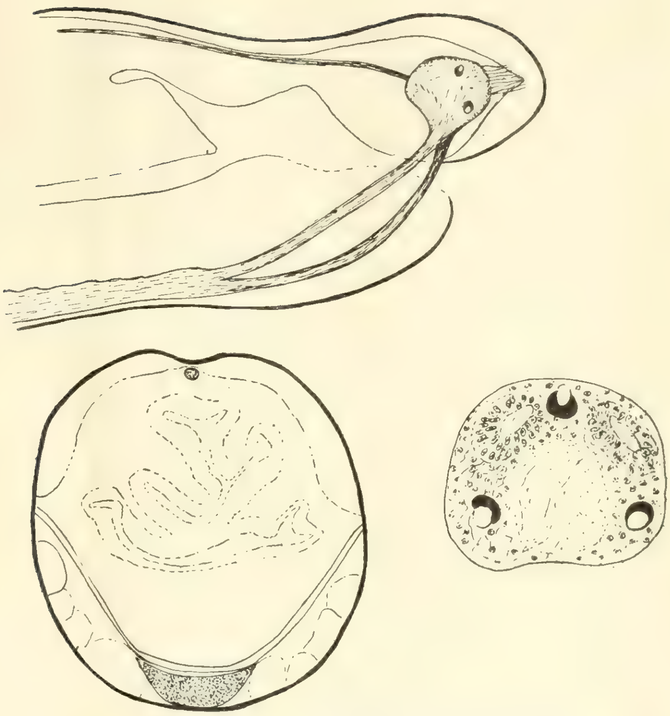
The nervous system has several features not described in related forms. There is a concentration of the central nervous system. There is a single large ganglion or brain in the snout above the mouth, from this two connectives pass ventrally to join the broad ventral nerve band in the mid-ventral line, while the only other longitudinal nerve noted was the very small mid-dorsal. Lateral nerves were not found.

The head or snout ganglion is provided with three eye spots, and unpaired dorso-median and a pair of latero-ventral ones. The sensitive region is so placed as to receive stimuli from above by the median eye and from below by the lateral eyes. The eyes are little more than concave pigment spots imbedded in the mass of the ganglion. A number of fibers pass from the ganglion forward to supply the thick sensory epithelium of the tip of the snout.

The ganglion is rather complex in structure. It has a central and somewhat ventral mass of fibers surrounded on all sides by nerve cells and fibers mingled. There are two centers composed each of cell areas surrounding a fibrous mass; these seem to be associated with fibers connected with the sensory epithelium of the snout and they resemble slightly the olfactory areas of certain invertebrate brains.

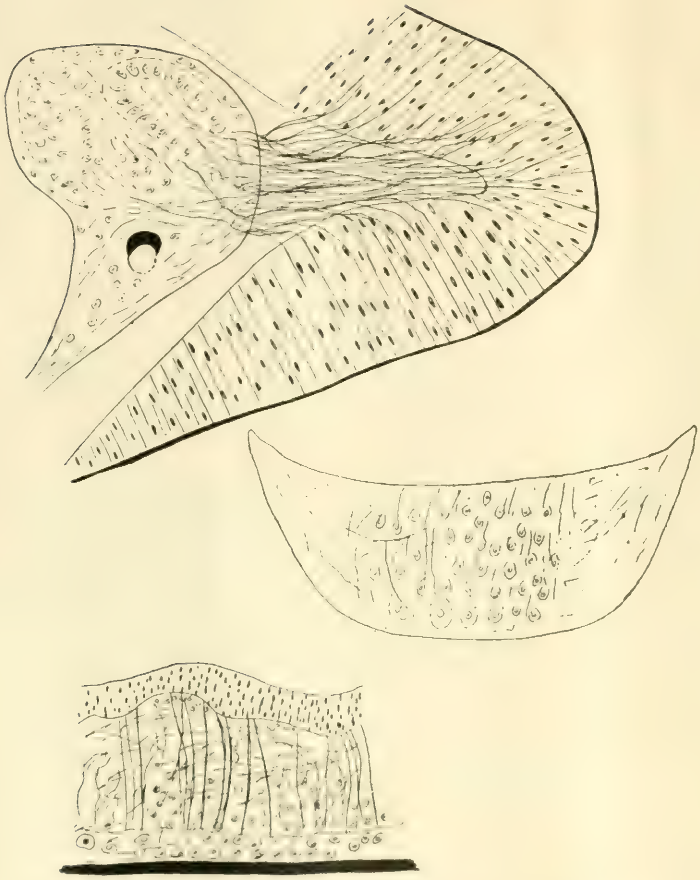
The dorsal nerve trunk is not cellular. The ventral nerve trunk is thick and broad. Ventrally it is nearly fused with the underlying cells of the body-wall, while dorsally it is bounded by a closely applied muscular layer. The nervous tissue itself is traversed by heavy lines which in part may be merely supportive in function, the lighter strands, both transverse and longitudinal, are branches from the rather abundant cells which are for the most part located ventrally.

(Contribution from the Zoological Laboratory of Pomona College.)



(FIG. 1.) EXPLANATION OF FIGURES

The figure above is a reconstruction of the head end of *Enoplus,* showing the position of the nervous system. The lower figure at the left is of a section through the whole body of the worm, showing the dorsal and ventral nerve bands. Both these figures enlarged 75 times. The drawing at the right is from a section through the head ganglion, enlarged 170 times. The dorsal side is up in all the figures.



(FIG. 2.) EXPLANATION OF FIGURES

The figure above is through the snout and ganglion of Enoplus. The central figure is a drawing of a cross-section of the ventral nerve band. The lowest figure is from a longitudinal section of the ventral nerve band with the muscular layer above and the body-wall below.

The dorsal side is up in all the figures and all are enlarged 275 times.